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Technology, teachers, and training: Combining theory with Macedonia's experience

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ABSTRACT

Numerous developing countries are currently planning or executing projects that introduce technology into their educational systems. This article asserts that such projects will have limited long-term success or impact until they are reconceptualized to incorporate three transformative concepts: teachers play the key role in determining the success or failure of such projects; change is a years-long process and not a one-time event; and teachers need ongoing support to adopt the technology and should be treated as stakeholders in the innovation-adoption process. In the Macedonian nationwide computers-in-schools project herein described, teachers received extremely comprehensive advance training in both computer use and methods of actively incorporating technology into their curriculum and teaching. Still, the majority of teachers were not successfully employing technology in the classroom three years after the training and deployment were carried out. This article applies the Concerns-Based Adoption Model (or CBAM, which describes how individuals' concerns evolve as they undergo the process of change and how these concerns may be addressed over time) to Macedonia's experience. CBAM serves as a lens through which to examine ICT-in-education efforts and determine whether they effectively match up with how teachers experience change and where there is room for improvement in such efforts.

Keywords: *Computer aided instruction; educational technology; technology teacher training; developing nations; ICT; technology social factors; Macedonia; CBAM Model*

INTRODUCTION

Many developing countries are investing in projects that introduce ICT into the educational environment in hopes of developing technologically literate workforces able to participate in the information societies and economies of the present and future. Scarce resources are being poured into these efforts and the desire to see results is strong. Yet planning, implementation, and evaluation concerns remain. Relevant policy insights into best practices regarding the implementation of these ICT-in-education projects may be gained from examining what has been learned in countries where the introduction of ICT into the classroom has been both taking place and studied for many years.

Over the past several decades, numerous efforts have been made to introduce technological innovations into classrooms across the United States. Scholarly examination of these projects has followed. Unfortunately, Wesley and Franks (1996) identify a pattern of widespread failure. Many, if not most, attempts made between 1970 and 2000 have resulted in the wasting of vast public sums on "unused, underutilized, or misapplied technologies and the loss of opportunity to apply those innovations effectively to reform" (Wesley & Franks 1996, p.2). Policymakers have placed most public blame for these failures—and their associated wasted expenditures—squarely

at the feet of teachers, who are seen as resistant to change (Richardson 1990; Gitlin & Margonis 1995; Wesley & Franks 1996; Adams 2003). This "blame game" has unfortunately continued and takes place around the globe (Perrotta 2012). Yet this short-sighted blaming of teachers leaves scholarly work that has identified multiple culprits unheeded and lacks methods for moving forward in terms of how to ensure technology will be meaningfully adopted in the classroom.

As technology is increasingly introduced into the realm of education, there is a troubling persistence of the attitude that the mere provision of technology will lead to its adoption and implementation into teachers' pedagogy. Although this issue has been identified and acknowledged by researchers for decades (Fullan & Pomfret 1977), it remains, and is exacerbated by the intensifying pace of change and technological advance. Gitlin & Margonis (1995) point out that teacher resistance can be for good cause, and that reasons given for it should be taken into consideration, since teachers often understand their vocation far better than those designing policy programs intended to modernize or improve educational output.

A much bigger problem is that many programs and projects aimed at introducing technology to improve or modernize the educational experience do not recognize teachers as the key agents of change responsible for promulgating innovation (or not); in addition, change is often seen as an "event," and not a process that takes years, not weeks or months (Loucks & Hall 1979). Thus, the incorporation of technology into an educational curriculum cannot be accomplished simply through initial training of teachers in computer use, nor even through higher-level instruction in the incorporation of computer-related technology into their teaching.

The process of technology adoption must be accompanied by years-long support that reflects teachers' concerns as they adjust to the new technology and make changes in their teaching styles and modes to adapt to it. The more complex an innovation is, or the more change that is required of a teacher, the longer the change process will take, and the less likely an innovation is to be successfully adopted (Hall 1975). By contrast, the more that teachers are involved in the change process (one recognized to be long-term in nature), respected as stakeholders in the change-promoting effort, and offered multiple forms of appropriate support and incentives by change facilitators, the greater the chances of successful outcomes (Brzycki & Dudt 2005; Hord & Huling-Austin 1986).

An even larger challenge looms for the developing world: technology (often in the schools) is now widely seen as the next "quick-fix panacea" to address development goals (Hosman, 2010b). Numerous developing country governments are purchasing computers, laptops, netbooks, tablets, etc. for many or all of the children within their territories, having bought into the notion that the youth of their country need technological skills and a modernized educational experience if their state is to compete in the global knowledge and information economy of the future. Unfortunately, teachers are rarely given consideration in this scenario; training is most often not a part of the government's budget plans for technology implementations, and teachers are neither consulted nor considered stakeholders crucial to successful technology adoption. In other words, developing country governments are making the same policy and implementation decisions that led to decades of widespread failure in the United States. This need not be the case.

This article examines a large-scale (nation-wide) computers-in-the-schools project in the country of Macedonia in which teachers were, in fact, given a great deal of consideration. This project provided the most comprehensive advance training we are aware of in a developing country context, and it was carried out on a nationwide scale: The entire population of primary and secondary school teachers received multiple trainings in both how to use technology and how to actively incorporate it into their curriculum and teaching before the computers were deployed (Hosman, 2010a). However, three years after project implementation, the majority of teachers still were not using ICT in the classroom—even though the vast majority of them were using ICT in

their daily lives. The mystery remains: Why are so many teachers unable or unwilling to make the transition from using ICT in their personal lives to using it while teaching (the stated goal of the program)? Our research addresses this question with evidence that the long-term support required to promote successful change was neither present in this initiative, nor designed as a part of the program from the outset. Fortunately, it is not too late to adjust behaviors and attitudes and provide a greater level of support to teachers in terms of technological adoption. This article identifies areas in which improvements can still be made to address Macedonian teacher concerns and to assist in the long-term change process.

Further, this article is of significant value to other developing countries embarking on technology promotion within their schools; it recognizes the importance of teachers as the stakeholder-agents of change and identifies best practices throughout the adoption-of-innovation process. As noted above, a teacher-focused reconceptualization of the entire technology-in-the-schools endeavor is both necessary and urgent, as numerous developing countries continue to pour both hope and money into such projects.

The article proceeds as follows: after presenting our theoretical framework for examining change and the adoption of innovation, our methodologies are briefly discussed. This is followed by a presentation of the case study—a description of the computers-in-the-schools deployments and training programs undertaken in Macedonia—the presentation of our data, and a discussion section that compares our findings with the theory and literature review. Before concluding, we offer recommendations for improvements that will address teachers' concerns and assist them in adjusting to and incorporating (technological) change into their teaching, both in the specific case of Macedonia and in other ICT-in-education projects elsewhere.

THEORETICAL FRAMEWORK

The theoretical framework for adoption of innovation this article utilizes is based upon the Concerns Based Adoption Model (CBAM), developed in the 1970s by the Research and Development Center for Teacher Education in Austin, Texas (Hall & Hord 1987), which itself is based upon the foundational research carried out by Fuller (1969) on stages of concerns experienced by teachers regarding the development of their teaching skills and abilities. The CBAM model has been widely adopted and validated in the academic fields of education and educational psychology since its introduction, but has not, to our knowledge, spread beyond these fields. Yet there is much that this framework has to offer to those from nearly any field studying technology for development, because the process of change in adopting innovations must be understood and addressed if similar projects are to have a greater chance at succeeding.

As noted above, this article argues that teachers are the key to educational innovation and improvement; their willingness to adapt to change will determine whether innovations succeed or fail. In the absence of an active intervention introducing change, teachers' general perceptions of good teaching remain rooted in their own educational experiences as students, from the primary level all the way through their days as a pre-service teacher (Tunks & Weller 2009). These perceptions have a strong tendency to persist, and if innovation and change are to occur, teachers must become convinced of the usefulness of innovating, which then must be reflected in changed actions. Change comprises thoughts and actions, perceptions and behaviors.

A theory of change is therefore appropriate to analyzing the process of teachers' adapting to and adopting of technology vis-à-vis their teaching. Rogers' diffusion of innovation theory (1983) has been widely used and provides invaluable descriptions of the change processes and constructs. However, we have adopted the CBAM model here because it provides a theoretical framework as

well as the tools with which to conduct the study and interpret the results. Perhaps most importantly, however, the CBAM model enables our research to focus specifically on the key players in the change process—the teachers (Donovan, Hartley & Struder 2007). Because of this, it also provides a useful framework not only for designing teacher training and development programs but also to encourage implementation of changes in policy (Hollingshead 2009, Khoboli & O'toole 2011)

In recent years, the CBAM model has been applied far more widely to investigate the implementation of computers in classrooms (Newhouse 2001), precisely because in order to address issues such as the effectiveness of directed technology interventions (as opposed to simply the availability of new technologies), it is necessary to take into account the specific concerns of the teachers who are being directed and required to make the requisite changes in order to adopt new technologies. The CBAM model views change as a process experienced by individuals seeking to—or asked to—change their behavior in particular ways (Loucks & Hall 1979). Thus, instead of focusing on improvement of student test scores or other final stage outcomes resulting from a technological intervention—the metric(s) of many policymakers and development and/or aid-organizations—this article focuses on the individuals crucial to innovation adoption—the teachers. Several additional points regarding the concept of change underpin the CBAM model: change is accomplished by individuals, and it is a highly personal experience. It involves developmental growth in feelings and skills, and it can be facilitated by interventions directed toward the individuals, innovations, and contexts involved (Anderson 1997).

CBAM comprises two major dimensions. The first—Stages of Concern (SoC)—describes the feelings and concerns experienced with regard to an innovation (see Table 1). The second—Levels of Use (LoU)—involves the individuals' behaviors as they experience the process of change (see Table 2).

Under the Stages of Concern dimension, the CBAM model posits the existence of a sequence of specific concerns through which adopters of innovations progress over time. Adopters advance from early stage concerns about self-oriented issues (Awareness, Informational, and Personal concerns), to intermediate level task-related concerns about the effective management and use of the innovation, to eventual higher-level concerns regarding the impact of the innovation on students and how to collaborate more effectively with fellow teachers to aid with the integration and even creative adaptation of the innovation (Consequence, Collaboration, and Refocusing concerns).

This model is expressly developmental in its construct. It proposes a predictable order of the emergence and progression of these concerns, theorizing that earlier concerns will, in general, subside in intensity before later, higher-stage concerns are expressed (Wesley & Franks 1996). These concerns may re-cycle themselves as teachers advance through the stages. For example, once a teacher reaches a higher-level stage of collaboration and refocusing concerns, they may formulate or adopt new techniques for making use of the innovation; this may have the effect of "re-cycling" them through lower-level stages of utilization, management, and time-management concerns. However, if the lower stages of concern are not resolved or addressed, then the higher states are not likely to attain or materialize.

Table 1: *Stages of Concern about the Innovation*

Clusters		Stages	Description of Expressed Concerns
Self Concern	0	Awareness	No awareness or concern about the innovation
	1	Informational	General awareness of or interest in innovation, noncommittal or unaware of personal investment
	2	Personal	Interest in uncertainty about the change in roles and new demands on skills and time brought about by innovation
Task Concern	3	Management	Attention predominantly paid to daily tasks and best realization of innovation possible. Focus on issues relating to efficiency, organizing, managing, scheduling, changing time demands, functionality of innovation
Other/Impact Concern	4	Consequence	Concerns over impact on students' learning experience and outcomes, and of how to use the innovation to improve outcomes
	5	Collaboration	Focus on increasing innovation's impact on students through collaboration with others
	6	Refocusing	One sees alternatives to current use of innovation, mainly to improve impact, and explores possibility of putting such improvements into practice

Adapted from Hall 1975

The second dimension of the CBAM model is the Levels of Use, which reveals how performance and activities change as the individual becomes more familiar with an innovation and more skillful at using it (Loucks & Hall 1979). Like the Stages of Concern, the Levels of Use are also developmental in nature. Once users have become aware of the innovation, they begin gathering information about it and preparing for its first use. After initial use, user behavior typically shifts to the mechanical level, upon which users generally stay until they figure out how to use an innovation with little effort, eventually becoming accustomed to the point that their behavior may be described as routinized. This behavior corresponds to the Task or Routine stage of concern. At that point, the individual may either move to any of the higher levels, back to level III Mechanical use, or remain at the Routine level indefinitely, according to whether his or her concerns have been addressed, and whether their motivations ultimately correspond to innovation adoption. At higher levels of use, behavioral changes are made based on the perceived needs of students, reflecting an Other, or Impact, level of concern.

***Table 2**: Levels of Use of the Innovation: Typical Behaviors*

	Levels of Use	Behavioral Indicators
0	Nonuse	No action is taken
1	Orientation	User seeks information about innovation
2	Preparation	User prepares to use innovation
3	Mechanical Use	User focuses most effort on short-term, day-to-day mechanical use of innovation with little time for reflection or creativity. Superficial use, attempting to master ability to use innovation
4	Routine	Use of innovation stabilizes, few changes being made in ongoing use
5	Refinement	User varies use of innovation to increase impact on students, focuses on both short-term and long-term consequences of use
6	Integration	User combines own efforts with those of colleagues to achieve collective impact at greater level of effectiveness
7	Renewal	User reevaluates quality of use of innovation, seeks modifications or alternatives to achieve increased effectiveness of impact, explores new goals for self and system

Adapted from Hall 1975; Hord 1981

The type of concern correlates with stage of innovation use. In order for teachers to be able to create a learning environment that enables students to achieve advanced skills in terms of analysis, evaluation, and synthesis of information through the use of new technology in the classroom, basic computer productivity skills are a necessary but insufficient condition. Teachers themselves first need to become technologically literate, and then may be able to analyze, evaluate, and synthesize information through the use of the new technology. Only then can they take the necessary step of reexamining fundamental beliefs about traditional classroom approaches to teaching that is necessary to speak of true integration of computers into education: of being able to think with computers in order to solve authentic problems, construct new knowledge, and develop higher order thinking skills (Gershner & Snider 2001).

However, teachers' actual progression along this continuum over time is by no means guaranteed. Sheingold & Hadley (1990) report that even teachers who take the initiative to upgrade their skills may require as many as five years to master computer-based practices, while van den Berg & Ros (1999) find that in 40% of schools involved in the many large-scale innovation projects in Western Europe that they have examined, the majority of teachers have not progressed past the (middle) level of self-concern three years after technology introduction. Similar surveys have not yet been carried out in developing world contexts. Our article thus makes an important contribution in this area.

Over time, CBAM has been accepted within the scholarly literature on education and educational psychology as both valid and reliable when assessing dimensions of change (Adams 2003). What is more, the predictability of the appearance and progression of both concerns and behavior regarding the change process among teachers is a salient aspect of the model that allows for the possibility of planning for effective methods of meeting teachers' needs and addressing their concerns as these develop and change over time.

As acceptance of the theory grew from the 1970s to the 1980s, the authors and formulators of the CBAM theory extended their research to examine the question of what makes for more effective innovation adoption, adding a particular focus on what can be done by those holding leadership roles within schools. According to the insights gained from studies focused on change facilitators, the CBAM model has added a further supposition: that change interventions will be more effective if they address the concerns that teachers express, at the time they are expressing them. Here, we define intervention as any action, event, or set of actions or events that influence use of an innovation, while those responsible for carrying out the interventions are change facilitators (Hord & Huling-Austin 1986). Change facilitators may include principals, administrators, teacher-trainers/teacher-leaders, superintendents, curriculum coordinators, staff developers, or anyone perceived to be in a position of leadership when an innovation is to be implemented.

In order to be effective, interventions should address teachers' concerns as they develop through the (predictable) stages mentioned above. That is to say, if teachers are concerned about what the technology is and how to use it, interventions should focus on addressing these issues, and may include direct training in how to use technology. However, if teachers' concerns have progressed to how to integrate into specific topical subject areas, interventions targeted to address these concerns may include in-service trainings directly on these topics, or they may focus on pairing advanced technology adopters with those who are less advanced. These are but two simplistic examples to illustrate the point that, in order to be effective, the interventions themselves must change and progress over time in order to address the teachers' own evolving concerns.

In more recent writing, Hall and Hord (2005) flesh out even more fully and forcefully their argument for continued support for teachers undergoing the process of change, positing that teachers with no follow-up support are less likely to implement changes, while implementation of innovation increases considerably when continued, regular support follows the initial introduction of change. Thus, CBAM advances three general requirements for teachers undergoing the process of change to advance to higher stages within both the stages of concern and use of innovation frameworks: an understanding of participants' concerns and levels of use, the timely addressing of these concerns and uses as they progress, and the provision of ongoing, continuous support.

METHODOLOGY

Data collection and interviews informing this paper were carried out from February–December, 2009. The field methods comprise a combination of individual interviews, surveys, focus group discussions, and participant observation. Our multiple methods approach is intended to triangulate information from diverse sources and allow for a more robust interpretation of findings.

Quantitative data collection was carried out primarily by a team of 12 local final year university students or recent graduates with prior experience in carrying out surveys and leading focus group interviews. The sample was designed as a combination of stratified and convenience sample: all eight regions in the country are represented by two schools (one city and one village school), including schools with both dominantly Macedonian and Albanian language of instruction (represented accordingly). The actual schools were randomly selected from the list of all primary schools. In total, the sample consisted of 16 primary schools. The subjects (teachers) were selected in the school among those who were available at the time of survey and focus group data collection. We requested 20 teachers per school to fill in a questionnaire. Surveys were carried out at each school, while focus group discussions took place in six randomly selected schools. In addition, there were individual interviews with the school director or some

representative of the administration in each school. All of the surveys, interviews, and focus groups were carried out in either Macedonian or Albanian, and subsequently translated into English.

Additionally, the authors carried out one-on-one semi-structured interviews with teachers and administrative officials from primary and secondary schools, ranking officials from the Macedonian Ministry of Education and the Ministry of the Information Society, the on-site project director responsible for the Macedonia Connects project deployment, the post-deployment project director, and other senior program directors and project managers at the related ICT-in-education and technology promoting projects.

CASE STUDY: MACEDONIA'S COMPUTERS-IN-THE-SCHOOLS PROGRAMS AND TEACHER TRAINING

The Republic of Macedonia is a small country in the middle of the Balkan Peninsula that gained independence in 1991, after the breakup of the former Yugoslavia. It is a diverse country, both in landscape and ethnicity. Over the past 10 years Macedonia's government policy has focused on developing an information-based society by promoting technological opportunities and ICT adoption among the institutions and citizens.

The initial idea for placing computers in Macedonia's schools dates back to 2002, when the late President Boris Trajkovski—a strong believer in the need for Macedonian children to learn modern IT skills—returned from an official visit to the People's Republic of China with the promise of a donation of nearly 2,000 computers from the PRC. This collaboration was extended to an additional 4,500 desktop computers and 450 servers later on. Microsoft later donated over 6,000 licenses for software (Nairn, 2006). Deployment of such a large amount of computers needed to be planned seriously and called for additional funding. Consequently, the President approached USAID—an organization already funding projects in Macedonia—which agreed to support the computerization process.

USAID subsequently initiated and took the leading role in Macedonia's ICT-in-Education projects. USAID launched three main projects: e-Schools (2003-2008), Macedonia Connects (2004-2007), and Primary Education Project (2006-2011). These projects function under USAID's Strategic objective: To mitigate the adverse social impact of the transition to market-based democracies. They have been working on multiple levels: Provision and deployment of ICT equipment, Internet infrastructure, software and content localization, and teacher training for ICT integration. To provide additional context, the Macedonia Connects project equipped nearly every school in the country (460 of them) with both computers and wireless Internet connections and through which the Internet was made available to citizens across the entire country. It also broke up the pre-existing monopoly in Macedonia's telecom sector (Hosman, 2010a). Prior to 2005, little more than half the country had Internet coverage and the existing monopoly telecom provider charged as much as $150 per month for dial-up Internet services—a truly prohibitive fee when monthly salaries in Macedonia at that time averaged around $200 (Hunsberger, 2006, Kampschror, 2006). It is not an exaggeration to say that for nearly all of the teachers, these computer-in-the-schools projects represented their first exposure to the Internet.

There are, in fact, two separate computers-in-the-schools programs in Macedonia, taking place in two stages, and it will aid the reader's comprehension to understand this distinction. The first stage comprised that which we have begun to describe above: multiple-approach programs aimed at training, provision of equipment, and connectivity, all of which were carried out under the auspices of USAID in the approximate time range of 2003-2008. As a result of these initiatives, every primary and secondary school is equipped with a computer lab, an Internet connection, and

all teachers have undergone comprehensive training, as described below. This project is the focus of our research.

The next stage of the computers-in-the-schools plan is the Government's project: "One Computer per Child" (OCPC), introduced in 2007 with the aim of providing computers to all students in primary and secondary schools throughout the country. This represents a scaling up of computerization in the schools by an order of magnitude: from one computer lab per school to one computer per child. It involves provision of entirely new equipment and the introduction and use of open source software.

Also important to note is that USAID's role is ongoing—as are those of its partner and supported organizations, such as the Primary Education Project—particularly in terms of training and support of the government's initiatives. In other words, USAID projects are no longer in charge of the deployment and provision of equipment, but the Primary Education Project will, in fact, be carrying out the training sessions that will accompany the government's OCPC program.

Our goal for this article was to measure teachers' Levels of Concern and Levels of Use, regarding the computerization in the schools associated with the *first* deployment: the USAID/e-Schools programs. The research informing this article was carried out approximately three years after the e-Schools project deployment took place, which corresponds to the (minimum) amount of time that a number of the scholarly contributors to the CBAM model assert is necessary to allow for change to take place and technology to be incorporated into teaching and curriculum by the teachers.

We believe that the government's OCPC project presents teachers with multiple new changes and challenges. At the time of data gathering and research, the OCPCs were not yet being used in the primary schools, but OCPC hardware deployment had begun in the secondary schools. For this reason, our article focuses on the primary schools only, allowing us to gauge teacher concerns and levels of use regarding solely the initial computerization program. Although we carried out interviews and surveys at both school levels, our data indicated that the secondary school teachers' responses were heavily influenced by whether or not they had received the OCPCs; or, in other words, by whether or not they had begun to be subjected to this second round of (significant) change, which was still incomplete in its deployment, and therefore it was not easy (or arguably possible) to capture its effects in our data.

Teacher training

All of the trainings implemented by USAID's projects aim to build local capacities by involving teachers as trainers and contributors in the creation of learning materials as well as in piloting equipment. For many of the trainings, master trainers and teacher trainers were selected from among the teachers, who either self-identified, or were nominated for this role by their school director. Advisors from the Ministry of Educational Development were also involved as master trainers and active members in the development of materials teams.

The trainings were developed by international experts and then adapted to address Macedonia's needs and realities: all content was localized and made relevant, and local ownership was developed vis-à-vis the eventual products and trainings (Nikolovska 2009). The trainings ranged from covering basic ICT skills to enable the teachers without pre-existing skills to use computers in a technical way, to trainings that were aimed at integration of the technology into the curriculum. The teachers already possessing basic ICT skills were able to attend just the advanced classes. In one way or another, *all* teachers in Macedonia received ICT training, including 14,000 teachers from all 360 primary schools (Nikolovska 2009). These trainings were

carried out over a four-year period, mainly as isolated events between which insignificant in-school support was provided for the trained teachers.

Survey Data

Our questionnaire was completed by 212 primary teachers. Most of the teachers included in the sample were female (72%), belonged to the middle age group category, from 31-50 years (56%), and were of Macedonian (75%) and Albanian (23%) background.

***Figure 1**: Satisfaction levels regarding teacher training*

In terms of assessing the training they received, as seen in Figure 1 above, 51% of the teachers felt it was sufficient or more than sufficient, while 49% of the total assessed the training as being less than sufficient.

Feedback from the focus groups revealed that many teachers believed that the training they had received was insufficient, particularly for those who are just beginning to use such technology:

> *No, we weren't satisfied. It was short, only a few days; I think that the training should last longer…I think that most of my colleagues are not ready for this.*
>
> *This is my first experience to work with a computer and there is some pleasure, but I haven't applied it in my class.*
>
> *What one does not apply, one forgets.*

In terms of additional training, a large majority of teachers (70%) reported interest in receiving more training in the use of ICT in their area of instruction. The teachers' responses in the focus groups regarding this question revealed that the majority of them desired additional intensive training in order to acquire basic computer skills, and then additional training that would be subject-specific. They also believed that the training would need to be thorough and systematic,

starting from the most basic levels and leading to the end goal—using computers in the instruction, while taking care that it complements the conditions in which they work and builds upon their prior knowledge, instead of introducing new changes mid-stream.

> *I would like to lead a math class with a computer, but one needs full training for that, a very good knowledge of Excel, and not only being able to open Excel, but to know what there is inside, tables, etc.*
>
> *Yes, we would like to have more training, but it should start from the easiest things and should progress step by step, and the training should last longer.*
>
> *If we start to introduce some changes, it should be systematic. We have attended training in Word, Excel, and I don't know what else, and now they will introduce Linux. The teachers haven't been trained in Linux and now we will have a gap once again.*

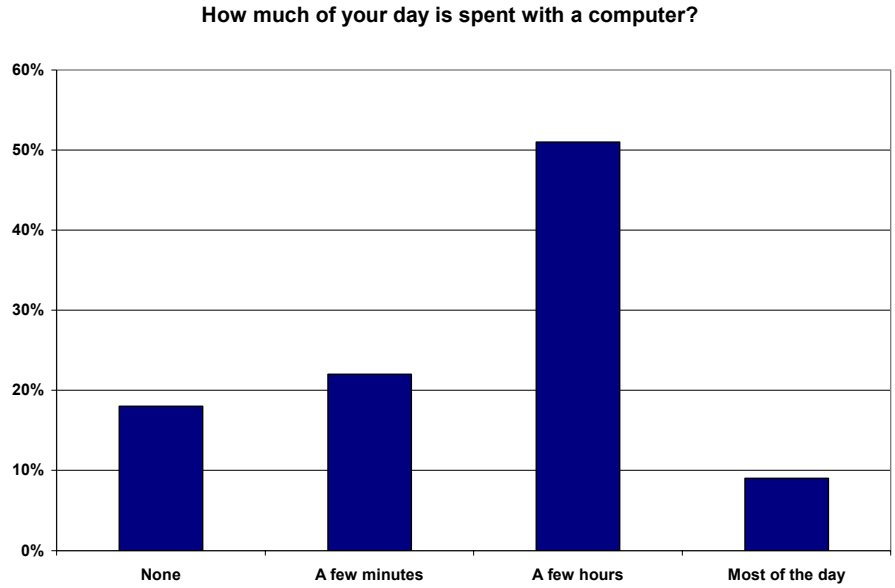

Figure 2: *Amount of time spent daily with a computer*

Eighty-two percent of teachers report using a computer on a daily basis. Of this number, 60% of the teachers are utilizing computers for a significant portion of the day—a few hours or more. By contrast, only 18% of teachers reported not using a computer daily.

Despite these high levels of daily computer use, a considerable percentage of teachers (44%) report *never* having used computers in their classes to date. As Figure 3 below shows, a similar percentage of teachers report having used this technology only a few times in their classes (42%), while only a small group of teachers say that they use computers very often (15%).

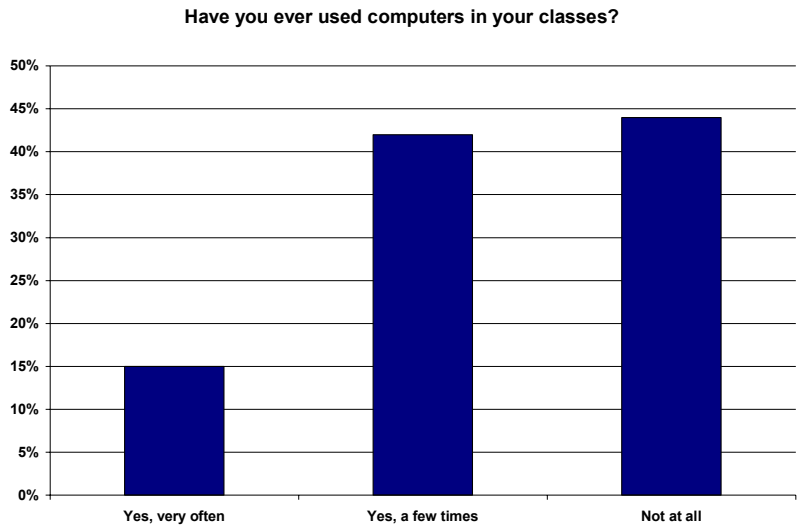

***Figure 3**: Teachers' use of computers in their classes*

When the time frame is shortened, the results are even more pronounced: 65% of teachers report not having used computers in their classes at all during the previous two months, as Figure 4 indicates. Just nine percent of teachers report using computers very often in their classes. These numbers offer a striking contrast to the 82% of teachers that report using computers on a daily basis, of which 60% use them for several hours or more each day.

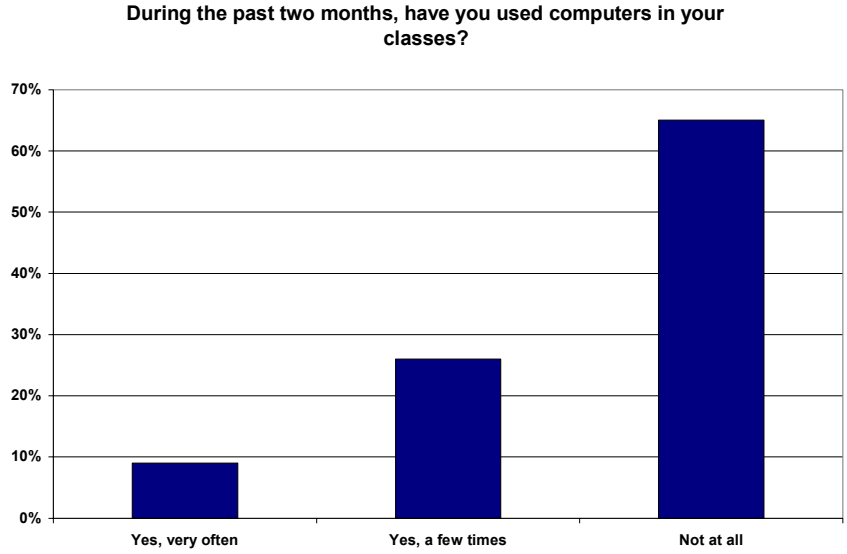

***Figure 4:** Teachers' classroom computer use prior two months*

In the same vein, nearly 60% of the teachers say that they rarely-to-never use ICT for instructional purposes, about one-third (30%) say that they sometimes use ICT, while a smaller number (10%) say that they use it quite often or all the time, as Figure 5 indicates.

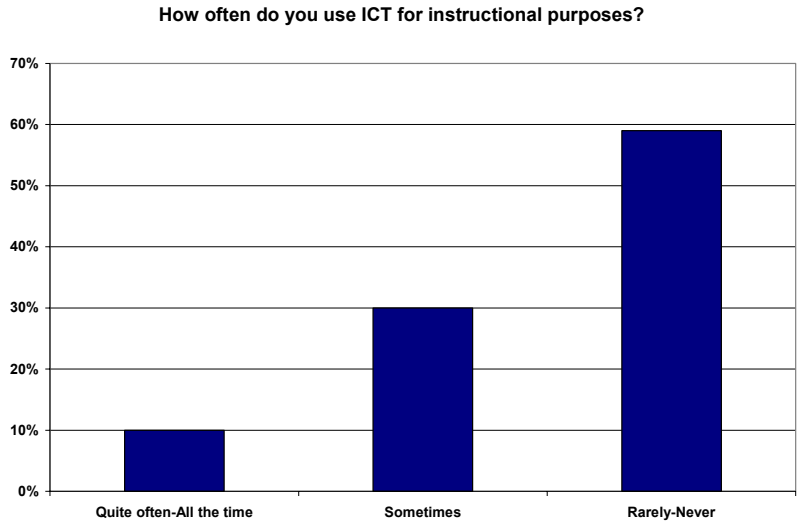

***Figure 5**: Frequency of ICT use for instructional purposes*

Given the statistics above, it is surprising that a rather large percentage of teachers report using ICT for preparing teaching materials and tests (72%), and for lesson-planning (63%). Yet less than a third of the surveyed teachers use ICT for activities with students, including activities such as: projects (30%); research (34%); working with data (26%); and student assessment (23%), as Figure 6 indicates.

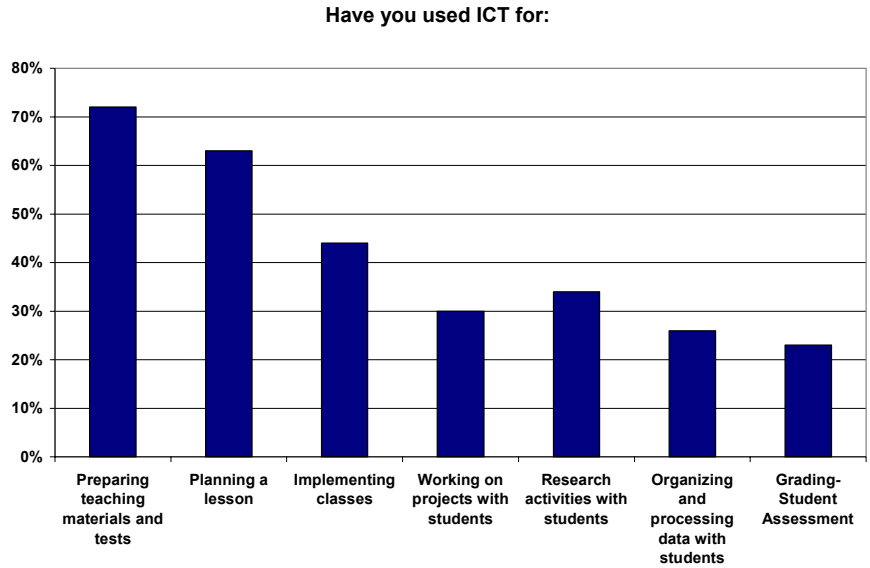

***Figure 6:** Teachers' uses of ICT*

In terms Internet use specifically, a very high percentage of teachers report using the Internet for research for teaching resources (83%); while a significant number use ICT for student research (43%); communication with colleagues (41%); and consulting on-line encyclopedias (48%), as shown in Figure 7. However, the Internet is used by very few teachers for communicating with students (11%) or parents (4%).

Regarding the difficulties of organizing and implementing instruction with computers, teachers in the focus groups pointed to the lack of material or equipment resources, but also expressed their awareness of being uncertain and lacking confidence in possessing the ICT skills needed for successful implementation.

> *We don't have enough contact with those [technological] things. The security and self-confidence within the teacher are not where they should be.*
>
> *Well, we need software for that [teaching]. It would make it easier if there were CDs with prepared lessons.*
>
> *Also, for example, there should be more LED projectors for the teachers. If we had those in our classrooms, it would be simpler. We would try to use them before or after class.*

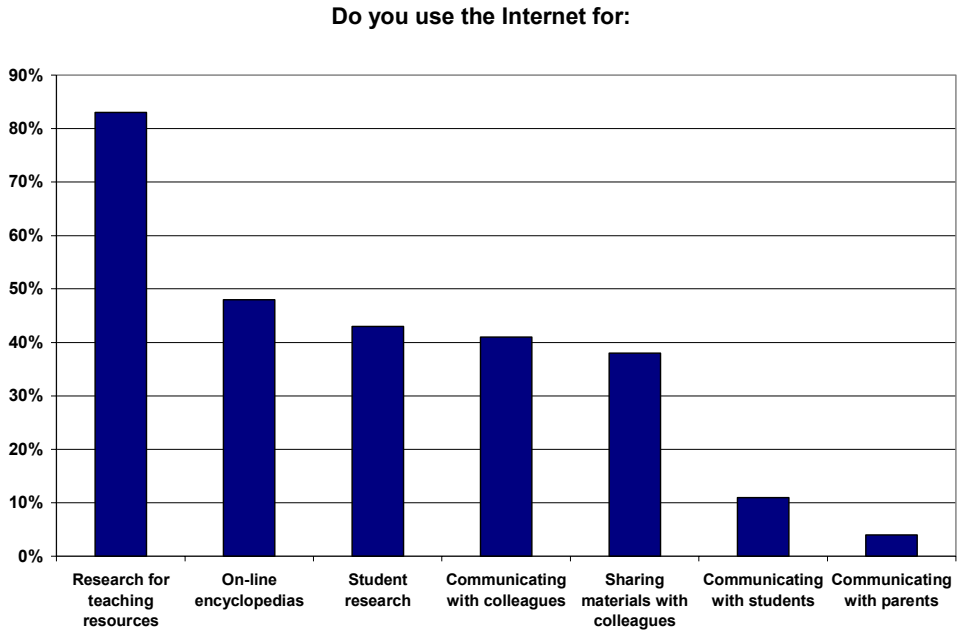

Figure 7: *Purposes of teachers' Internet use*

On the whole, the teachers are very positive about the idea of ICT in the schools. An overwhelming majority (86%) indicated that they believe that the school is the right place for students to learn basic computer skills. In the focus groups, the teachers also reported that their students are also extremely enthusiastic about using computers.

> *The students are very interested in computers. I can see that in my class.*

Yes, it is noticeable. They ask immediately when there are no computers or Internet in our classroom.

However, there is a significant disconnect between such positive attitudes held by the teachers and the actual usage data, which indicate that nearly 60% of the teachers are not currently using ICT in their instruction. This apparent contradiction may be attributable to a number of factors. One of these is an overriding concern, expressed by the teachers during the focus groups discussions, that they lose control over the class when students have a computer that they can pay attention to instead of the teacher, and that for successful realization of ICT in the instruction, it is necessary that the teacher retains control and knows when to turn off the computer, as one cannot learn solely using the computer. Another factor is the higher degree of technological expertise teachers attribute to their students vis-à-vis themselves, which leads to a feeling of insecurity and loss of authority. Finally, there is a concern that too much change is being forced upon the teachers, and they do not have sufficient time to adapt.

It is clear that as a learning means the computer should be used much more. However, there are many things for which the computer needs to be turned off, and [instead] to pick up and read a book. The computer cannot be the replacement of all things.

They are the experts! They know computers and they learn the [technology] faster than I do and then they ask questions I cannot answer.

Sometimes I feel that there is just too much change coming too fast without enough planning or support for teachers. I wish they would just slow down.

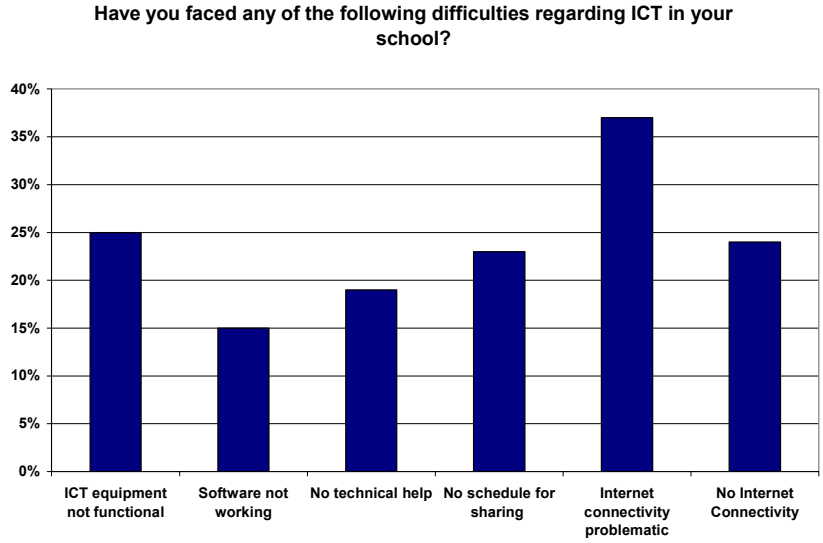

Figure 8: *Teachers' difficulties in use of ICT*

Regarding maintenance issues, 44% of the surveyed teachers say that there is no single person responsible for maintaining the ICT equipment. Twenty-two percent report that when problems do

occur, they are not managed efficiently, while 23% report that the equipment is not safe (parts of or entire computers have been stolen), as shown in Figure 8.

More than half of the teachers surveyed (56%) do not know whether their school has prepared an annual plan for the use of ICT equipment, while 29% say that such a plan has not been developed in their school. Only 15% report that their school does have an annual plan for the use of the ICT equipment. This is an indication that the vast majority of school administrations have not been providing a comprehensive program of support for teachers. If such a plan exists but teachers are not aware of it, then they clearly have not been involved in its formulation or implementation.

In general, teachers feel that the school administration supports them in using the computers: 53% assess administrative support as being sufficient, while 37% think that they could do more. However, in our opinion, teachers may not be aware of what the administration could be doing to support them. Support, in this context, may refer to a positive attitude and verbal support towards using computers. In this article, however, we argue that support must include a system of actions and interventions that will help the teachers deal with change, including making additional trainings available, establishing a school-level plan for ICT integration so that expectations are enumerated, clear and predictable, supporting teacher collaboration groups, and providing additional resources and encouragement as these are needed. In the focus groups, many teachers pointed out that the responsibility for the computers in the schools does not rest with their local administration, but rather depended on higher level officials who need to decide on key issues regarding the technology provision and usage, as well as on teacher professional development and training.

On a positive note, nearly all of the teachers agree that the introduction of technology into the schools has been useful for them as teachers (98% partially-to-completely agree). At the same time they resoundingly agree that it has been a challenging experience for them (93% partially-to-completely agree).

DISCUSSION

Our literature review indicated that even overwhelmingly positive teacher attitudes towards ICT were not enough to bring about the successful implementation of a new program, curriculum, or method of teaching. This was clearly evident in our data, as 86% of teachers surveyed in Macedonia were positive about using computers in the classroom, yet only 34% report actually having used computers in their instruction within the previous two months. In addition, 44% of the teachers reported never having used computers in their classes to date. This data indicates that approximately half of the teachers that have had both training and access to technology have never progressed above Level 0, (Nonuse) in our Levels of Use framework, indicating that their corresponding concerns about using technology have not been addressed.

Despite our findings of widespread non-use of computers in the classroom, teachers are, in fact, making use of computers in their daily lives, and in their work-related planning, preparation, and information-gathering, on a much more frequent basis: 75% of teachers indicate using computers in their personal lives, 72% use ICT to prepare teaching materials and tests, and 83% use the Internet to search for teaching resources. Only 18% don't use a computer at all during their normal day. This indicates that nearly three-quarters of teachers have progressed to at least Levels 3 and 4 in the Levels of Use categories (Mechanical and Routine use) in their personal lives and teaching preparation, but have not been able to make the transition to using technology in the classroom in a meaningful way. Less than a third of teachers reported using ICT for activities with their students.

These results are significant and merit further discussion. If the goal of the technology intervention had been simply to increase computer use among teachers, the project may be considered successful, given the percentage of teachers that use this technology in their personal lives, on a daily or weekly basis, even for pedagogical preparation. However, the fact that the goal of the program was to promote ICT use within the classroom means that there is substantial room for improvement. Given that there was no ongoing support for the teachers—one of the three critical "best practice" requirements identified in this article—the lack of technology use in the pedagogy should not come as a surprise. What is more, Hall and Hord (2005) argue that for change to become permanent, and for teachers to be able to sufficiently advance on the stages of concern and levels of use continuums, a time period of at least three-to-five years is necessary. This survey took place three years after the intervention and training. Lack of funds, combined with a significant change in on-the-ground circumstances as described above, have prevented the authors from carrying out a follow-up survey at the five-year stage.

When asked in the focus group setting about concerns regarding technology use in the classroom, we found the majority of teachers' stated concerns to be at both early- and intermediate-level stages, which include self-concern and task/time management issues. Statements that reflected these levels of concern included concerns about insecurity using ICT in front of students, or of being able to retain control of the classroom while using technology. In addition, desire for additional training, hardware, equipment, and software was expressed. There were no statements we could locate that reflected higher order concerns about, for instance, the technology's impact on students' learning experience and outcomes, a desire for increased collaboration among teachers, and/or the proposing of alternatives for improvement of technology in order to increase impact. We believe this indicates that there is room for improvement in addressing teachers' concerns, which should correspond to increasing levels of technological integration and implementation into the teaching, instead of remaining at the lower-order level of simple mechanical and task-oriented use of technology.

The literature that focused on the role for administration identified a number of success factors, in terms of what administration can do to support teachers confronting change. These interventions involved both asking and anticipating teachers' concerns in an ongoing fashion over a long period of time (at least three years), addressing these concerns by offering multiple and varied trainings over the years as skills and interest levels change, and facilitating opportunities for group formation and collaboration among teachers. We are not aware of administrators in these schools taking an active role in any of the interventions described above. It may be the case that administrators are not familiar with these methods for supporting teachers, and that teachers themselves are not habituated to expect this kind of support from their administrations. We argue, however, that instituting a program of active interventions, for a years-long period of time, will result in more positive outcomes for the teachers, in terms of adapting to change and to technology adoption and its use in the classroom.

One method for facilitating this process would be to involve the administration in the training process from the outset of project implementation: to enlighten them to the fact that the change process is a years-long experience for teachers and what their role can be in this process; to offer them a separate training in how to support teachers and actively intervene to alleviate teachers' concerns during the change process; and to encourage them to allow for increased group formation and collaboration among like-minded teachers. To our knowledge, this type of training and information sharing has not been carried out in the Macedonian context, but it is not too late to start including administrators in such trainings, which are scheduled to continue for the teachers as part of the OCPC program.

One obstacle worth noting, in the Macedonian context, is the political appointment of school administrators. School directors are changed when local mayors from different parties are elected. Thus, even if one school director is "on board" with the type of support and interventions mentioned above, if she/he is replaced every few years, the administrative support system that has been developed will fall apart. Macedonia's Ministry of Education recently announced its intention to depoliticize administrative positions in the schools: an important step toward ensuring continued support of teachers during times of significant change.

Two other related areas in which a great deal of room for improvement exists are the putting forth of a plan for using ICT in the schools (on a school-by-school basis), and the establishment of a plan for computer maintenance and upkeep. Our data showed that more than half of the teachers surveyed did not know whether their school had prepared an annual plan for the use of ICT, while 29% knew that their school did not have such a plan. That left just 15 percent of teachers who knew that their school had promulgated a plan for the use of ICT. The development of such a plan would offer an opportunity for discourse between teachers and administration; teachers could express their concerns and offer input for the administration's response. Not developing a plan not only misses this opportunity entirely, it also leaves a school rudderless, setting no expectations for ICT use by either teachers or students; this can leave teachers confused and directionless.

In a similar vein, our data showed that 44% of teachers reported that there was no person responsible for the maintenance of ICT equipment and security of the equipment remained a major concern. Project implementers must consider allocating funds for a full-time maintenance staff person for each school, and possibly a security staff person, if every single student and teacher will soon have a computer at their disposal at all times.

Macedonia's nationwide computers-in-the-schools programs have been of a "top-down" nature; that is to say, imposed on the schools from above. Although we believe that there can be benefits from this approach, particularly in terms of efficiency, economy of scale, and equality of opportunity and provision, there are also potential drawbacks. Our literature review identified significant obstacles to teacher buy-in when, for instance, they have not been involved as stakeholders in the process in any meaningful way, when their opinions have been disregarded or not solicited, when they are not given sufficient training or support to manage change, or when they are not allowed room for creativity in implementing change. We find that there is much more room for soliciting teachers' input in the current technology rollouts in Macedonia, and in fact, the need for this is much more urgent at present, because the government's OCPC program will require a greater degree of change on the part of teachers, in terms of learning new software, having a computer at the desk of each of their students (as opposed to having a computer lab available within the school), and being required to use the computer in a minimum number of subjects. If the government does not act in good faith to solicit teachers' input on the multiple changes they are facing simultaneously, our literature review suggests that they will likely face a significant amount of foot-dragging and even backlash from the teachers.

One positive point to note is the exceedingly high percentage of teachers expressing interest in additional training. A majority of our survey respondents expressed satisfaction with the training they had received up to the time our research was carried out, and a still greater number expressed the desire for even more training in the area(s) in which they teach. Additional trainings are already in the works, as the government's decision to utilize open source software will require such. Therefore, it is not too late to take teacher input into consideration in the context of these future trainings.

Another best practice—identified in the literature—to encourage teachers in the change process is offering incentives. Financial incentives may not be practical in many developing-country

contexts. However, there are other methods for incentivizing. In Macedonia there exists a system of career development in the letter of the law, yet it is not implemented in reality. Professional certification represents a potential area for teacher incentivization. Another area for incentivization is through competitions or events where teachers can show the results of their (or their students') work. Such competitions and challenges are in the process of being organized (by USAID's Primary Education Project) on multiple different topics.

The need for a continuous school-based support and mentoring program for teachers was identified above. One proposed method is to establish an Educational Technology Support Teacher (ETST) in each school. The ETST would provide teachers with hands-on training in the use of different ICT equipment and support them by suggesting manners in which ICT can be integrated into different subjects.

We believe that we have identified some success factors, as well as areas for improvement in addressing change involving technology in the classroom, in Macedonia and elsewhere.

CONCLUSION

This article advocates a complete rethinking of the design, implementation, and evaluation of developing world computers-in-the-schools projects. It posits that the success—or failure—of such projects hinges on change as it is experienced by teachers; that such change takes place over time, and that teachers must have their concerns addressed and have access to ongoing support as this evolution takes place. The CBAM model was presented as a framework for understanding these concerns and the corresponding levels of technology use; it is through this framework that concerns may be addressed to increase the prospects for project success.

Past policy efforts in the United States have been driven by the misguided belief that the simple provision of technology will foster change; this has been mirrored in many developing world ICT-in-education projects, leaving teachers out of the equation. The Macedonian nation-wide computers-in-the-schools program analyzed herein emphasized teacher training in both technology use and implementation, yet the training constituted a one-time event. Computer use in the classroom and integration into the pedagogy was not yet achieved three years after the technology and trainings were provided; quite clearly there is room for improvement.

Administrators must take active roles in the technology adoption scenario; they must address teachers' concerns regarding the changes necessary to the process, and intervene to address those concerns as they evolve over time. This active involvement may include in-service training and the encouragement of collaborative work between teachers. This type of support must be ongoing.

The promulgation of a school-wide plan for ICT is necessary to inform teachers of what is expected of them; including teachers in developing such a plan involves them as stakeholders and allows projects to benefit from their input and an understanding of their concerns. We have also advocated the creation of the role of "technology support teacher" in the Macedonian context, but acknowledge that budget constraints in other countries may not allow for the creation of such a position, or at least for the presence of such a person in every school. However, all computers-in-the-schools projects must consider the costs and manpower necessary for upkeep, maintenance and repair—and often security—from the outset; regardless the limitations of the budget, these expenses cannot be ignored.

As identified in this article, the three transformative concepts of ICT-in-education projects are as follows: teachers will determine the success or failure of such projects; change requires time; teachers need ongoing support to adopt the technology and should be treated as stakeholders. If

these concepts are ignored, we predict that these projects will follow trajectories similar to those witnessed in the United States, where provision of technology alone was considered sufficient to its adoption and the blame for project failure was, time and again, placed on teachers. Fortunately, these pitfalls can be avoided. New projects can adopt these insights and existing projects can be amended to incorporate them; this article identifies specific measures to do so. Basic computer productivity skills are indeed necessary to achieve real integration of technology into the educational experience, but these skills alone will not enable the creation of meaningful synthesis for learners. Fundamental technological change in the classroom requires that teachers and learners alike must be able to think with computers in order to solve problems, construct knowledge, and develop high order thinking skills.

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